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2,882,571

METHOD OF CASTING METALS

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2 Sheets-Sheet 1

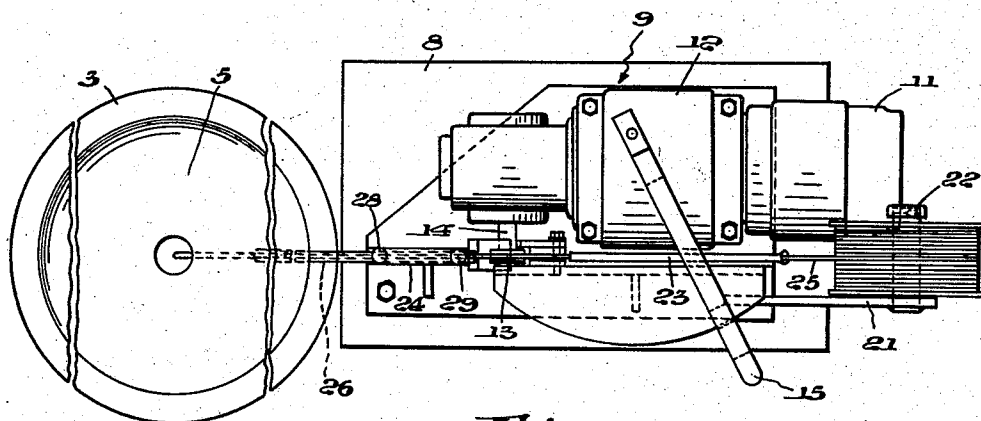


Fig. 1.

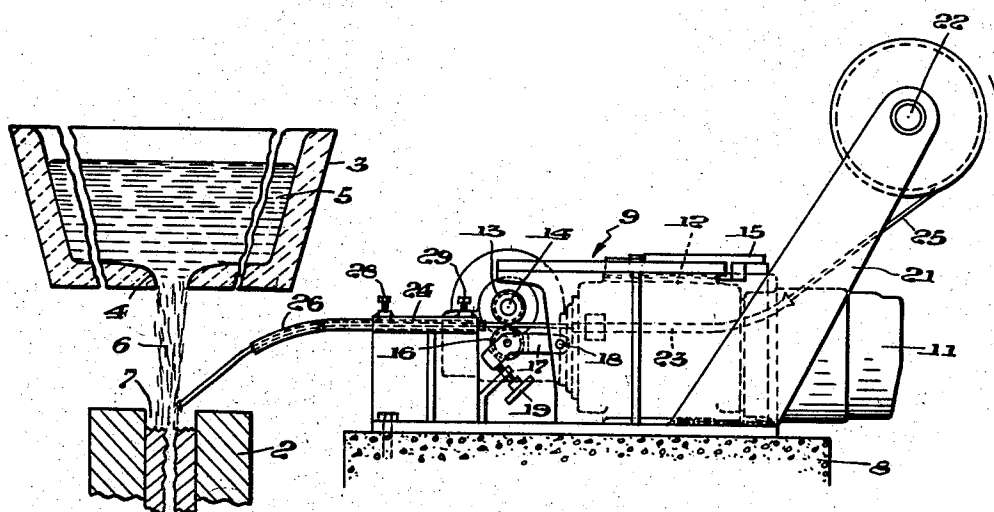


Fig. 2.

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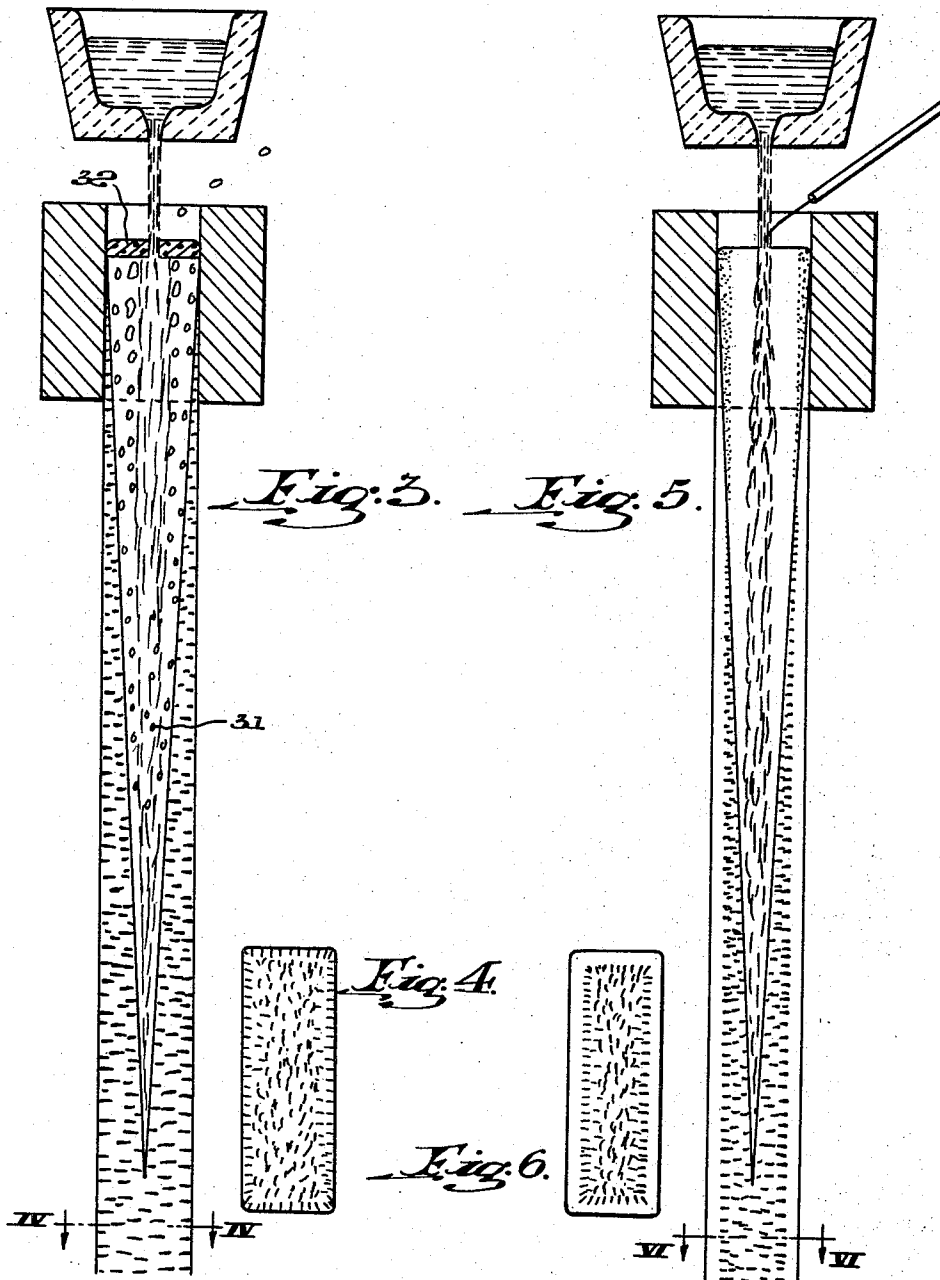
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1

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METHOD OF CASTING METALS

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4 Claims. (Cl. 22—200.1)

This invention relates to a method of continuously casting molten metals and more particularly to a method of continuously casting rimmed steel.

In the ingot casting of rimmed steel, it has been the practice to add aluminum pellets to the molten steel for the purpose of controlling the depth of the rim which is produced by gas evolution resulting from the reaction of iron oxide and carbon in the steel. The addition of aluminum or other deoxidizers serves as a "killing" agent that unites with the oxygen present in the ingot and stops all further rimming action. In the past, the degree of deoxidation obtained has been adjusted in ingot casting by adding the aluminum mostly in the pouring ladle with small amounts being added to the individual molds during the actual pouring of the ingots. These small amounts have been introduced into the molds in the form of pellets, the pellets being manually tossed into each mold by a workman standing alongside the molds.

In the continuous casting of rimmed steel, it has been found undesirable to add too much aluminum in the tundish since the aluminum oxide that is formed results in undesirable clogging of the tundish nozzle and a stopping of the "heat." To avoid this, aluminum has been added to the cast by tossing it in the form of pellets onto the molten metal surface in the mold, substantially in the same manner that such pellets have been tossed into the mold in the ingot casting of rimmed steel. In continuous casting, however, the molten metal surface area is relatively small and the depth of molten metal in the casting is relatively great so that this method of adding a deoxidizing agent has not proved entirely satisfactory. For example, when using the pellet feeding method, extreme turbulence has occurred at the metal surface, this turbulence proving to be a hazard to the workmen in the area of the casting, and further indicating an undesirable deoxidation adjustment.

More particularly, this undesirable deoxidation adjustment is brought about by the fact that the aluminum pellets which have been tossed into the mold tend to float on the surface until they melt and, after melting, the molten aluminum tends to float on the surface until it has been dissolved, mixed, or oxidized. After oxidizing, by reaction with oxygen in the steel or in the surrounding atmosphere, the oxide then tends to float so that a thick scum layer of mixed aluminum, aluminum oxide, and aluminum-rich steel accumulates. With this condition obtaining, the stream of metal from the tundish picks up a small amount of the aluminum and scum as it enters the mold, but not enough to materially affect its properties. This stream of metal, due to its velocity and energy, flows deep down into the molten metal crater, mixing with the cooler metal already there. The metal then flows back up along the solidifying walls of the casting and, as it does so, it is cooled both by the mixing and by the flow of heat to the solidifying walls, with at least a portion of it also solidifying. During this cooling and solidification of the metal, gas evolution occurs in the cast, providing that

2

the ferrostatic pressure is not too great to inhibit such evolution. Since the oxygen content of the molten metal is relatively high, this gas evolution occurs quite deep in the casting with the gas bubbles increasing in size as they rise due to the progressive decrease of ferrostatic pressure. Accordingly, there is a violent, general evolution of large gas bubbles from the molten metal surface, such turbulence often being sufficient to splash molten metal out of the mold in a hazardous fashion. The resulting slab of rimmed steel has blow holes extending to or very nearly to the surface, very poor surface qualities with cold shuts and passages of scum, and scabs where the molten metal has splashed against the mold wall.

The present invention avoids the many above-mentioned disadvantages, providing a method of continuously casting steel which includes the feature of introducing a deoxidizing agent into the mold in such a manner that only a light, readily removable scum is formed along the molten metal surface. The present invention further provides a method of continuously casting rimming steel wherein the surface of the metal in the mold is relatively smooth and quiet compared to the extreme turbulence obtained when using the above-mentioned pellet feeding method, thus providing an easier, safer, and more dependable method of casting rimming steel. Various other features of the present invention will become obvious upon a reading of the disclosure set forth herein.

More particularly, the present invention provides a method of continuously casting rimmed steel comprising continuously pouring molten steel of rimming qualities as a stream from a supply zone to an open-ended mold zone and continuously feeding a deoxidizing agent into said molten metal stream beyond said supply zone and before the stream reaches the surface of the molten steel in the mold zone.

It is to be understood that various changes can be made in the several steps of the method disclosed hereinafter without departing from the scope or spirit of the present invention.

Referring to the drawings:

Figure 1 is a top plan view of a continuous wire feeding apparatus positioned adjacent an open-ended mold and arranged to carry out the method of the present invention;

Figure 2 is a side elevational view, partially in section, of the apparatus of Figure 1;

Figure 3 is a schematic sectional view of a continuous casting apparatus and cast wherein adjustment of deoxidation in the cast is accomplished by the process of adding aluminum shot or pellets to the surface of the molten metal;

Figure 4 is a cross-sectional view of the cast taken in a plane passing through line IV—IV of Figure 3;

Figure 5 is a schematic sectional view of a continuous casting apparatus and cast wherein adjustment of deoxidation in the cast is accomplished by the present inventive process;

Figure 6 is a cross-sectional view of the cast taken in a plane passing through line VI—VI of Figure 5;

Referring to Figures 1 and 2, an open-ended mold 2 is disclosed having superposed thereabove a molten metal supply zone in the form of a tundish 3. Tundish 3 is provided with a nozzle 4 at its lower portion from which the molten metal 5 in the tundish can pass as a stream 6 from the tundish to the inlet side 7 of mold 2.

Positioned adjacent the open-ended mold 2 in spaced relation therefrom is a concrete base 8. Base 8 serves to support a deoxidizing agent feeding apparatus designated broadly by the reference numeral 9. More specifically, the feeding apparatus 9 includes an electrically powered motor 11 connected to a speed reducer unit 12. Reducer unit 12 serves to drive feed roll 13 through a shaft 14

3

of the unit. It will be noted that a throttle arm 15 is connected to the reducer unit in order that speed adjustments of feed roll 13 can be made manually.

Co-operating with the driven feed roll 13 is an idle feed roll 16, this idle feed roll being mounted in a bifurcated bell crank 17, the base end of which is mounted for pivotal movement about fulcrum 18. To effect the pivotal movement of the crank and idle roll 16, a screw-down arrangement 19 is provided to co-operate with the other end of the crank.

Mounted on the upper end of a support arm or stanchion 21, the other end of which is fixed to base 8, is a spindle 22, the support arm being so arranged that the spindle 22 is positioned above the feeding apparatus 9. Positioned between the spindle 22 and the feed rolls 13, 16 is guide member 23. Guide member 23 serves to guide a deoxidizing agent wire 25, mounted in a spool on spindle 22, from the spindle to the feed rolls. A second guide member 24, contoured so as to have a downwardly directed end portion 26, is positioned on the other side of the feed rolls. The downwardly directed end portion 26 serves to guide the deoxidizing agent wire 25 into the stream of metal 6 flowing from the tundish 3 so as to enter such stream at a point just above the molten metal level in the mold 2. In order to assure proper adjustment of the end 26 to accomplish this, a pair of spaced screw down adjusting members 28 and 29 are provided to regulate the position of the guide member 24 and its guide end 26.

In carrying out the present invention, a deoxidizing agent such as an aluminum wire spool is mounted on the spindle 22. Simultaneous with the pouring of the metal 5 from tundish 3 as a stream 6, the wire is fed by feed rolls 13, 16 through the guide 23, guide 24, guide end 26, and into the stream 6 of molten metal, the wire entering the stream at a point above the molten metal level in the mold 2.

In one advantageous embodiment of the invention the wire is fed to the stream at a rate so that the aluminum comprises .10% to .005% of the total weight of the metal cast. With the deoxidizing agent being added to the stream by the inventive process described, the velocity and kinetic energy of the metal stream entering the mold carries the deoxidizing agent deep down into the casting, the deoxidizing agent mixing with the metal already present and rising along the solidifying casting walls (Figures 5 and 6). Thus, the deoxidation effected is much more complete than is the deoxidation accomplished by the process where aluminum pellets are added (Figures 3 and 4), and, when gas evolution occurs in the inventive process, it is not in large bubbles as disclosed by reference numeral 31 in Figures 3 and 4 but only in the form of

4

very small bubbles of very great numbers which rise along the solidifying wall. Unlike the process of tossing the aluminum pellets into the mold, the large bubbles 31 are eliminated as well as a thick, scum layer 32 at the top of the mold.

Thus, with the inventive process a condition is produced that is conducive to a flushing action, providing rimmed steel of a commercially desirable type with a rim of steel free of blow holes and suitable for rolling into a quality product.

What is claimed is:

1. A method of continuously casting rimmed steel comprising continuously pouring molten steel of rimming qualities as a stream from a supply zone to an open-ended mold zone and continuously feeding a deoxidizing agent into said molten metal stream beyond said supply zone and before the stream reaches the surface of the molten steel in the mold zone.
2. A method of continuously casting rimmed steel comprising continuously pouring molten steel of rimming qualities as a stream from a supply zone to an open-ended mold zone and continuously feeding a deoxidizing agent stream into said molten metal stream so that said deoxidizing agent stream merges with said molten metal stream beyond said supply zone and immediately before the surface of the molten steel in the mold zone.
3. A method of continuously casting rimmed steel comprising continuously pouring molten steel of rimming qualities as a stream from a supply zone to an open-ended mold zone and continuously feeding an aluminum wire into said molten metal stream beyond said supply zone and before the stream reaches the surface of the molten steel in the mold zone.
4. The method of claim 3 wherein said aluminum is fed to the stream at a rate so that the aluminum comprises .10% to .005% of the total weight of the metal cast.

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